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Axisymmetric orifice flow for measuring the elongational viscosity of semi-rigid polymer solutions

A. Mongruel [a,*], M. Cloitre [b]

[a] *Laboratoire de Rhéologie et Mise en Œuvre des Polymères, Université Pierre et Marie Curie, 60 rue Auber, 94408 Vitry-sur-Seine, France*

[b] *Laboratoire Matière Molle et Chimie, Unité Mixte CNRS ATOFINA, ESPCI, 10 rue Vauquelin, 75231 Paris Cedex 05, France*

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Abstract

We study experimentally semi-dilute solutions of xanthan, a semi-rigid polymer, flowing through an axisymmetric orifice. The pressure drop through the orifice and the size of the secondary vortex upstream of the orifice are measured simultaneously as a function of the flow rate. The results indicate that xanthan solutions behave like suspensions of rigid rods in a Newtonian solvent. Quantitatively, this analogy is supported by a theoretical analysis which combines a macroscopic flow model and the use of a microscopic variable reflecting the contribution of the rods to the bulk stress. With this simple model, it is possible to obtain the elongation viscosity of semi-rigid polymer solutions and estimate unknown macromolecular parameters.

Keywords: Contraction flow; Rigid rod suspension; Semi-rigid polymer; Elongational viscosity; Vortex growth